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COPPER PITCH ORE.

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A jet black to brownish pitch-like material rich in copper is frequently encountered among the supergene minerals of copper deposits. It has a conchoidal fracture and when occurring in large enough pieces, closely resembles obsidian or even anthracite coal. It seems to vary in hardness from less than 3 to about 4 and is sometimes very brittle. It often grades into portions that are more or less sooty, thus increasing its resemblance to coal. It is frequently associated with copper oxide (cuprite) with comparatively small amounts or even no other copper minerals closely associated with it. (Analysis No. 1). Such specimens seem to possess the maximum hardness if we except those varieties which contain considerable chalcedony. In other cases, and more characteristically perhaps, it is associated with blue and greenish chrysocolla, malachite and limonitic material. Sometimes the mass appears rather streaked with the black, brown, blue and greenish material intermingled. Specimens of copper pitch are mostly opaque even in thin slivers though one sample from Katanga, Belgian Congo, while black in the hand specimen appeared quite transparent on the thin edges. This specimen seemed to grade into chrysocolla, perhaps with an excess of silica.

Not many analyses of this material have been published, its evident colloidal and impure nature serving to deter one in this endeavor. It is mentioned in most mineralogies sometimes being described under limonite and at others under chrysocolla. Thus in Naumann-Zirkil's *Elemente der Mineralogie* (1907, p. 505) it is stated that the mineral " . . . . scheint ein secundäres Gemenge von Eisenoxydhydrat mit dem Silicat Kupfergrün oder mit Kupferoxydul und Kieselsäure zu sein." Tschermak[1] also mentions it under limonite and describes it as an alteration product of copper ores and associated minerals, and states that it contains copper silicate. Niggli[2] also mentions it under limonite, and refers to the presence of P_2O_5 in some samples. Analyses in which phosphorus has been determined do not appear to be available, yet we believe it not to be an important constituent.

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[1] Tschermak, *Lehrbuch der Mineralogie,* **1905,** p. 466.

On the other hand, Des Cloizeaux[3] mentions it under chrysocolla and gives an analysis by Damour on material from Turjinsk in the Urals in which there is a high percentage of iron and silica. (Analysis No. 2). This probably was a mixture of chrysocolla and limonite. Both Hintze and Dana[4] describe it under chrysocolla but state that it is a mixture of copper silicate and limonite.

In the United States copper pitch is described, usually very briefly, as occurring in tne most important copper districts. Thus Weed[5] mentions it from the Butte District, Montana, but no analyses were made and the author was uncertain whether it corresponded to the Arizona material. He described it as a "lustrous coal-black or dark-brown crust associated with other copper ores." B. S. Butler[6] also mentions it from the San Francisco Region, Utah. He states: "It is probably variable in composition, but contains considerable amounts of copper, iron, manganese and water." Ransome[7] recognized manganese as an important constituent in the material from Globe, Arizona, as he reports under the heading "chrysocolla." He writes: "It varies widely in color from delicate apple green to turquoise-blue, to dark green, brown or black, the darker shades being apparently due in most cases to the presence of the oxide of manganese."

A more detailed investigation of some of the best American material, *i.e.*, the blackest and most coal-like, seems to show that at times iron is not an important constituent, and that even silica may be present in rather inconspicuous amounts. Thus Koenig[8] analyzed material from Bisbee, Ariz., to which he gave the name of Melanochalcite, that contained only 0.07% iron oxide and 7.80% of silica. (Anal. No. 3). This type of copper pitch ore was further investigated by Hunt and Kraus.[9] These authors are not in favor of the carbono-silicate idea as there appears to be too small a percentage of silica. Recasting their own analysis as well as that of Koenig they find the Bisbee material corresponding to 30.8% tenorite, 30.8% chrysocolla and 38.4% malachite according to Koenig's analysis, and 68% tenorite, 20% chrysocolla and 11.4% malachite, according to their analysis. (Anal. No. 4). The writer's analysis shows still less silica corresponding to a still less admixture of chrysocolla (Anal. No. 1). Furthermore Hunt and Kraus, in examining their material in a very fine powder form, found evidence of a mixture such as suggested by their recast analyses. They also show that Koenig's material was probably non-homogeneous though thought to be pure by him. The writer's material from Bisbee corresponds in appearance to that described by Koe-

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[2] Niggli, *Lehrbuch der Mineralogie*, **1926**, p. 681.

[3] Des Cloizeaux, *Manuel de Mineralogie*, **1862**, V, I, p. 125.

[4] Hintze, *Handbuch der Mineralogie*, Bd. II, **1897**, p. 462. Dana, *System of Mineralogy*, **1892**, p. 699.

[5] Weed, Geology and Ore Deposits of the Butte District, Mont., *U. S. Geol. Sur., Prof. Paper. No.* **74**, p. 81.

[6] Butler, Geology and Ore Deposits of the San Francisco and Adjacent Districts, Utah. *U. S. Geol. Sur., Prof. Paper, No.* **80**, p. 98.

[7] Ransome, Geology of the Globe Copper District, Ariz., *U. S. Geol. Sur., Prof. Paper, No.* **12**, p. 123.

[8] Koenig, On the new Species Melanochalcite and Keweenawite, *Am. J. Sc.*, (4), **14**, 1902, p. 404.

TABLE OF ANALYSES OF COPPER PITCH ORE

	No. 1. Guild. Bisbee.	No. 2. Damour. Urals.	No. 3. Koenig. Bisbee.	No. 4. Hunt. Bisbee.	No. 5. Lindgren-Hillebrand. Clifton-Morenci.	No. 6. Guild. Globe.	No. 7. Buehrer. Huerta Arriba.
SiO_2	2.95	17.95	7.80	4.31		24.64	5.75
Al_2O_3	0.00					3.10	
Fe_2O_3	0.64	50.85	0.07	0.22	4.00 (+Al & P.)	1.73	4.40
CuO	84.22	12.12	76.88	88.94	28.6	33.68	62.3
CaO	0.36					0.84	
ZnO	0.25		0.41	0.12	8.4	tr.	
MnO	0.28				21.20 (as MnO_2)	19.19	0.00
H_2O	6.91	20.55	7.71	4.48			
CO_2	5.17		7.17	1.78			
Insol.					22.8		
Ignition					13.7	17.76	
Total	100.78	101.47	100.04	99.85		100.94	

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[9] Hunt and Kraus, Composition of Melanochalcite, *Am. J. Sc.*, (4), 41, p. 211, 1916.

nig, Hunt and Kraus, and others except that the nodular masses are embedded in nearly white, hard kaolinized matter, practically free from greenish or bluish oxidation products. It surrounds centres of crystalline cuprite and certainly appears to be an alteration (hydration) product of it.

Lindgren has investigated copper pitch ore from the Clifton-Morenci District, Arizona.[10] Most of this material had been considered an impure chrysocolla, but Lindgren proved it to be entirely distinct from that mineral. (Anal. No. 5). He states: "As shown by the optical characteristics, however, they are not a mixture, and they certainly do not contain any chrysocolla. . . ." The amount of insoluble residue in the analysis of Lindgren and Hillebrand might indicate its presence, perhaps in solid solution. Limonite, however, cannot be considered as an important constituent in the Clifton-Morenci material as only 4% Fe_2O_3 ($+Al_2O_3$ and P_2O_5) is reported. This is also true of the two samples analyzed by the writer (Anal. Nos. 1 and 6). Here only 0.64% and 1.73% are found. In this respect, prehaps, the specimens differ somewhat from what had been described as copper pitch ore in many of the German texts.

Silica also would appear to be an unimportant constituent in certain types of this material as shown by one of the analyses of the writer. (No. 1). Only 2.95% SiO_2 was found. Therefore, in this case at least, it cannot contain any considerable quantity of chrysocolla.

Likewise in other important respects copper pitch minerals differ widely in composition, that from Bisbee containing practically no manganese, while the Globe and Morenci specimens show 19.19% (reported as MnO) and 21.2%, respectively, (reported as MnO_2). (Anal. Nos. 6 and 5.) Carbon dioxide also occurs in some types in quantities that cannot be neglected, although Hunt and Kraus refer this to malachite and have been able to detect this impurity in the fine powder. There seemed to be no particular evidence that it is present as a carbono-silicate as suggested by Koenig in 1902. The material from Bisbee analyzed by the writer contained 5.17% CO_2 by direct determination. The material was very homogeneous and associated only with cuprite which occurred in the centre of nodules of copper pitch, the whole being embedded in hard nearly white kaolinized rock. There was no evidence of copper carbonate which might have made its appearance as green or blue stains in the immediate vicinity. Yet the specimen effervesced lively when treated with hot hydrochloric acid. This percentage of CO_2 should, when recast to malachite, show a sufficient amount of the carbonate to be easily seen by the lens, unless, of course, it be in the form of a solid solution or colloidal mixture, an explanation which seems to be the most probable.

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[10] Lindgren, Copper Deposits of the Clifton-Morenci District, Arizona, *U. S. Geol. Sur., Prof. Paper, No.* 43, 1905, p. 115.

The other sample analyzed by the writer (No. 6) is quite different in mode of occurrence as well as in composition. It appears in large masses sometimes the size of a fist, yet consisting of uniform, pure black pitchy-like material with conchoidal fracture. This may grade into streaks of brown still possessing the pitchy appearance and conchoidal fracture, or it may pass into dark greenish or bluish streaks of irregular outlines. It is further found mingled with more or less ocherous limonitic material or closely associated with crystalline azurite and malachite. Even clean light blue patches of chrysocolla may appear and grade off into the black or brownish pitchy types. Black sooty areas are also to be found which soil the fingers and react strongly for manganese.

The specimen from Globe, Arizona, analyzed by the writer (No. 6) was taken from material such as is described above, the blackest portions possessing the best conchoidal fracture being chosen. The material selected did not soil the fingers appreciably and does not effervesce with HCl. It would seem from the analysis to be a mixture (probably) of hydrous oxides of manganese and copper with, perhaps, some chrysocolla. This material corresponds to the type partially analyzed by Lindgren and Hillebrand (No. 5) from the Clifton-Morenci District.

Specimens received from Huerta Arriba, Province of Borgos, Spain, are of particular interest because of the large quantity of the material represented. Usually copper pitch ore, although occurring in most copper deposits that have been subjected to considerable oxidation, is found only in small patches. That described from Globe, Arizona, as occurring in sizes up to three or four inches without variation from the pure black pitchy material, seems to be about the limit so far as individual pieces are concerned. At Huerta Arriba, however, the material was said to be obtained for a time in car-load lots. This was at first thought by the observer[11] to be some type of coal and a test was even made in a convenient forge. A partial analysis made by Dr. T. F. Buehrer is given in table No. 7. On close inspection this material shows numerous but very inconspicuous spots of some greenish copper mineral probably malachite. The large masses, however, much resemble coal though more friable than many of the other samples examined. This type of copper pitch seems to correspond very closely to the Bisbee variety. Carbon dioxide though not determined seemed to be present in considerable quantities.

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[11] Courtenay DeKalb, personal communication.

RÉSUMÉ

Copper pitch ore, as described by various writers, seems to be a mixture of several hydrous oxides, often with silicates and carbonates, in a more or less colloidal state.

The foregoing investigation seems to emphasize the possibility of this substance containing rather insignificant quantities of both iron and silica. Therefore, the tendency to group this mineral with either limonite or chrysocolla should not be too greatly stressed.

It ordinarily occurs only in small quantities as incrustations and streaks in oxidized material, though in one case (Huerta Arriba, Spain) it was reported to be found for a time in car-load lots.

It may be classified into the following types according to the relative amounts of the oxides present:

(1) A more or less colloidal mixture of the hydrous oxides of copper and iron. This seems to apply more nearly to those types described in the German texts and frequently listed under limonite.

(2) A mixture of oxide of copper and chrysocolla. This applies especially to those specimens, containing considerable silica, and seem to grade into chrysocolla.

(3) A mixture of the oxides, more or less hydrated, of copper and manganese. Silica may also be present in considerable quantities.

(4) A hydrous oxide of copper. These varieties (melanochalcite) have considerable carbon dioxide which is difficult to account for. If present as copper carbonate it must be colloidally mixed.

(5) A fifth type might be mentioned to cover those types where the copper pitch and the admixed chrysocolla grade into chalcedonic varieties. These become so light in color and seem to grade off into chrysocolla in such a manner that they may well be considered as variations of that mineral.

THE PROPERTIES AND ASSOCIATED MINERALS OF GILLESPITE.

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In the description of gillespite, $Fe''BaSi_4O_{12}$, published[1] some years ago but brief mention was made of some of its properties and of its associated minerals. Only a single small specimen was then available (now in the U. S. National Museum) and it was hoped that more of it might be found, thus furnishing abundant material for investigation. As such a hope has been in vain, the results obtained on the original material and not previously published are here presented.

The mineral is tetragonal as rectangular cleavages are developed on the base. Two cleavages are present: basal, well developed, and pinacoidal *a*(100), much poorer. There is in some flakes a suggestion of a very poor third cleavage after *m*(110). Thin sections of the specimen and isolated fragments of the mineral show that the following crystal forms are present: *c*(001), *a*(100), *m*(110). Redetermination of the refractive indices gave values practically identical with those first determined. ϵ (red) = 1.618, ω(colorless or pink in thick pieces) = 1.619. The pleochroism of gillespite in a thin section is most striking. It forms a remarkable example of that class of minerals whose pleochroism (in thin pieces) varies from colorless to a strong color.

The glistening silica scales which retain the shape of the original mineral when it is treated with HCl, have lost all the iron and barium of gillespite and have taken on some water. Examined optically, they are seen to be uniaxial, negative, with some scales showing a slight opening of the axial bars. The refractive indices are somewhat variable, ϵ being determined as 1.441 and 1.455 and ω as 1.449 and 1.465. The mean index is about 1.45. Analysis of such silica scales, air-dried for several days, gave: SiO_2, 83.7; H_2O, 15.9; non-volatile with HF, 0.3; total 99.9. Another determination made by J. G. Fairchild, of this laboratory, gave an ignition loss of 15.73 per cent.

The water content of these silica scales is not constant but varies slightly from day to day and even during a single day, the variation amounting to about one per cent. Over concentrated H_2SO_4 in a desiccator, the total loss is 4.4 per cent, nearly all of which is reabsorbed on exposure to the air.

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[1] Schaller, W. T.; Gillespite, a new mineral: *Journ. Washington Academy Science*, vol. 12, p. 7 (Jan. 4), 1922.

Mr. J. G. Fairchild made some dehydration determinations on these silica scales, at different temperatures, finding that some water was retained by the scales even at 400°.

LOSS OF WATER OF SILICA SCALES

Temperature C°	Percentage of total water loss	Temperature C°	Percentage of total water loss
65°	4.47	260°	10.58
90°	5.24	300°	11.83
110°	5.92	350°	12.13
150°	6.35	400°	13.10
200°	9.85	Ignition	15.73

The total ignition loss obtained by Fairchild (I obtained 15.9 per cent on another sample) corresponds to the water percentage (15.72) in the formula $8SiO_2 \cdot 5H_2O$. Of these five molecules of water, practically 2 pass off at 110° (loss at 110° = 5.92 per cent, whereas 2 molecules water = 6.28 per cent), the third around 200°, and the fourth and fifth above 200°. Even a temperature of 400° does not quickly drive off all the water.

It is to be noted that the water content is nearly the same, on a ratio basis, as that of the iron and barium of gillespite. Thus:

$$\text{Gillespite} = 8SiO_2 \cdot 2FeO \cdot 2BaO$$
$$\text{Silica scales} = 8SiO_2 \cdot 2H_2O \cdot 2H_2O \cdot H_2O.$$

There is a slight excess of water which may be adventitious, especially as the silica scales do not maintain constant weight during the day.

The associated minerals are: white celsian, grayish-green hedenbergite (previously called diopside), colorless quartz, and a few specks of several undetermined minerals observed in thin section. The approximate mineral composition of the specimen, calculated from the weights of the separated minerals (heavy solution and electro-magnet), is: gillespite 64, celsian 15, hedenbergite 15, quartz 6.

The analyses of these associated minerals are as follows, all being only approximate, and made on small quantities of material perhaps from 90 to 95 per cent pure.

Analyses of Associated Minerals

	Celsian	Hedenbergite	Quartz
SiO_2	33.9	50.8	94.4
Al_2O_3	25.6	2.9	....
FeO	....	18.1	....
CaO	....	22.2	....
BaO	37.7	0.0	....
MgO	....	6.6	....
Insol. HCl	0.4	....	....
Total	97.6	100.6	94.4

The celsian fills in the spaces between the gillespite and partly between the gillespite and the hedenbergite. Alkalies were not determined but the barium determination shows the mineral to be nearly pure celsian. The optical properties also indicate a nearly pure celsian. They are: $\alpha = 1.584$, $\beta = 1.589$, $\gamma = 1.596$. 2V close to 90°. $Z \wedge a$ axis $= 30°$ approx. Definitely positive.

The hedenbergite, from the analysis, is about $2/3\ CaO \cdot FeO \cdot SiO_2$ and $1/3\ CaO \cdot MgO \cdot SiO_2$. Larsen determined its optical properties as follows: $\alpha = 1.704$, $\beta = 1.714$, $\gamma = 1.735$. Positive, 2V medium large, dispersion $\rho > \nu$. The hedenbergite is largely in the form of nearly equant grains scattered through the celsian and the gillespite and to a smaller extent it occupies the spaces between these two minerals.

The undetermined minerals, noted only as specks and small masses scattered through the specimen are briefly described. There are three of them. The most abundant is fibrous (probably a secondary alteration product) with strong pleochroism-parallel to the elongation, blue with intense absorption (almost black); and normal to the elongation a yellow with almost no absorption. The third direction is almost colorless to very pale yellow. Extinction is parallel or nearly so, and elongation is positive. Birefringence moderate, estimated at about .02 to .03. The refractive indices are less than those of celsian. The second mineral is also strongly pleochroic from blue to yellow-brown but is not fibrous but forms short prismatic or irregularly shaped masses, with apparently parallel extinction and similar moderate birefringence. It may be the same as the fibrous mineral. A third mineral, strongly pleochroic from yellow to deep brown with moderate birefringence has a shape similar to the second mineral, but is much scarcer, only a few fragments being noted. The very limited quantity of available material has prevented the more complete determination of the properties of these rare associated minerals.

MINERAL DETERMINATION BY ABSORPTION SPECTRA. II.

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In the first instalment of this article[11] the minerals showing absorption spectra consisting of narrow bands were discussed. There remain to be considered those in which the bands are mostly broader, at least as seen with the microspectroscope; these will be grouped according to color. For particularly broad bands the wave-lengths of both margins and center will be given, and as before, positions of brilliant transmission will be indicated by parallel lines. When data obtained by other workers with larger spectroscopes are cited, only the lines of significance in the present connection will be tabulated.

PART 2. ABSORPTION SPECTRA CONSISTING OF BROAD BANDS

Group 1. Color red or pink.

Spectrum-zone	red		orange yellow	green	blue	
Corundum, pink	–700||690–683–675	...	600–590–580	...	...	W.
" , ruby	–700||**690–680–670**	...	600–575–550	...	...	W.
" , "	–696||**693 679–676**	661	...	...	477	M.
" , " , syn.	–700||**690–678–665**	...	600 — 555 — 510		...	W.
Element	Cr		Cr			

This highly diagnostic spectrum of the red corundums was first described by Moir,[12] and independently by Keeley.[13] The former, using a large spectroscope, observed several narrow absorption bands within the broad ones shown by the microspectroscope. The red line visible (in scattered light only) between the end of the spectrum and the band starting at about 690 is strikingly brilliant; in a later article, Keeley[14] gave evidence that it is connected with fluorescence. The width of the band in the orange and yellow varies markedly with the chromium content, and as synthetic ruby contains considerably more of this element than natural material of similar depth of color, this band can be turned to account for distinguishing them: when it extends well over into the green, the specimen is almost certainly synthetic.

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[11] *American Mineralogist*, **14**, pp. 299–308, 1929.

[12] The spectrum of the ruby. *Trans. Royal Soc. S. Afr.*, **1**, 321, 1908; **2**, 271, 1912.

[13] Microspectroscopic observations. *Proc. Acad. Nat. Sci. Phila.*, **1911**, 106–116.

[14] Notes on absorption spectra of certain minerals. *Festschrift Victor Goldschmidt*, 170–171, 1928.

Spectr.-zone	orange	yellow	green	blue	
Almandite	620 ...	**585–578–570**	530–525–520‖**510–503–495**	...	W.
“	(615) ...	... **575**	... 530 ... **507–506–505**	(460)	M.
“	... ...	... 571 ± 4	. . . . 503 ± 3	. .	W. & H.
Pyrope	620–590–560	...	... ...	...	W.
“	... ... **561**	...	... ...	...	W. & H.
Elements	Cr	Cr	V V		

The variations in the spectra of certain garnets are brought out by tabulating the results of observations with the microspectroscope along with those obtained with more elaborate instruments by Moir[15] and by Weigel and Habisch.[16] It is obvious that by this method pyrope can be readily distinguished from almandite, and both from ruby, even when they are cut and mounted so that other methods of testing are inapplicable. Spessartite shows the same bands as almandite, but fainter.

Spectrum-zone	yellow	green	blue	
Rose-quartz	... ...	(520–495–470)		H.
Ruby-spinel	(580–560–540) ...		... ...	W.
Rhodonite and	580–560–540 ...		... ...	W.
Rhodochrosite	... 554		... ...	W. & H.
Eudialyte	... ...	**535 ± 3** ...	... ...	W. & H.
Pink-topaz	(570–550–530) ...		... ...	W.
“	... ...	525 ± 13 ...	... ...	W. & H.
Thulite-zoisite	... 560–545–530		... ...	W.
Piedmontite, α	... ...	525 —— ——	—— ——	L.
“ β	**590–560–530** ...		... ...	L.
“ γ	600 —— —— ——	—— ——	—— ——	L.
Rubellite-tourm.	... (560 ——	525	—— 490) ...	W.
“	... ...	**517 ± 16** ...	... ...	W. & H.
Element	Mn	Mn	Mn	

The absorption bands of the manganese minerals just tabulated are mostly weak, but in certain cases species which resemble one another can be told apart by this means. The data tabulated are taken in part from articles by Holden,[17] Weigel and Habisch (*op. cit.*) and Laspeyres.[18]

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[15] Notes on the spectra of the precious emerald and other gem stones. *Trans. Royal Soc. S. Afr.*, **2**, 273, 1912.

[16] Mineral colorations. 1. The absorption of red-colored minerals in the visible part of the spectrum. *Neues Jahrb. Min. Geol., Beil. Bd.*, **57A**, 1–56, 1928.

[17] The cause of color in rose quartz. *Amer. Mineral.*, **9**, 101, 1924.

[18] The crystallographic and optical properties of piedmontite. *Z. Kryst. Min.* **4**, 435–467, 1880, especially plate 11.

Spectrum-zone	ora. yellow green
Cuprite	**630** ... ... W.
Erythrite	... ... **560–550–540** ... (495) W.
Roselite, etc.	... ... (570–555–540) ... ... W.
Vanadinite	... 580–565–550 ... ... W.
Ruby-glass	600–580–560 ... ... W.
"	... ... 530±6 ... W. & H.
Elements	Cu Cu V Co Se? Co

This table of miscellaneous compounds concludes the list of red materials showing noteworthy absorption bands thus far recognized.

Group 2. Color yellow or brown.

Spectrum-zone	yel. green blue
Greenockite	... **525–520–515** ... W.
Corundum	... ... **455** W.
Vesuvianite	... ... 463 B.
Staurolite	(555) ... ... W.
Elements	Fe Cd Fe

The most significant band in the spectrum of any of the few yellow minerals exhibiting restricted absorption is that in the blue; its cause is evidently ferric iron, and it shows up also in minerals colored green by this element. In vesuviantite, as noted by Becquerel[19] it appears only in the ordinary direction.

Group 3. Color green.

Spectrum-zone	red ora. vio.
Hiddenite-spodumene	... ... 630 438 B.
Emerald-beryl	... 640 ‖ 620 ... W.
"	680 (656) (633) ... M.
Demantoid-garnet	... (640) (620) ... W.
Fuchsite-muscovite	... (650) ... ... W.
Cr-borate	680 ... ... M.
Element	Cr Cr Cr Cr

The bands of minerals colored green by chromium are not so intense as of those colored red by this element, yet are fairly characteristic. The data marked B. are taken from a paper by Bayley,[20] those marked M. from that by Moir, already cited.

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[19] The absorption spectrum of epidote (etc.). *Compt. rend.*, **108**, 282–284, 1889; The laws of light absorption in crystals, *ibid.*, 891–894.

[20] X-ray coloration of kunzite and hiddenite. *Phys. Rev.*, **29**, 353, 1927.

Spectrum-zone	ora.	gre.		blue		vio.	
Emerald-corundum	...	...	...	...	**455**	...	W.
Spinel	...	...	(490)	...	(458)	...	W.
"	...	...	...	...	458	...	M.
Olivine	...	**500 – 495 – 490**			(460)	...	W.
Vesuvianite	...	...	...	...	463	...	B.
Epidote	...	...	(478)	...	**458**	...	W.
" α	...	...	...	...	**453**	...	B.
" β	...	...	**474**	...	**457**	427	B.
" γ	(603)	...	...	...	...	...	B.
Clinochlore, ε	...	.	493	. .	. .	. .	B.
Element	Fe		Fe		Fe	Fe	

This second table of green minerals comprises those whose color is due to iron. The band toward the violet side of the blue is also shown, as above noted, by those colored yellow by the ferric form of this element; that toward the green side may be due to the ferrous form. The data attributed to Moir (M.) and to Becquerel (B.) are from papers by these authors already cited.

Spectrum-zone		red			ora.	yellow		blue	
Manganosite	...	...	...	||**650–615–575**||			...	...	F, W.
Alexandrite-chrys.	...	...	...	...	**600–585–570**			(480)	W.
" "	678	667	656	645	. .	**585**	...	...	K.
Andalusite (gem)	...	...	...	...	...	...	**555**	525	W.
Elements	V	V	V	V	Mn	V	V	V	

The intense band in the orange produced by manganosite was first noted by Ford[21] and the four narrow ones in the red characteristic of alexandrite-chrysoberyl by Keeley (*op. cit.*, p. 171). That vanadium causes the color in this final list of green minerals is a suggestion only, and needs confirmation.

GROUP 4. COLOR BLUE.

Spectrum-zone	red	ora.		yellow		gre.			blue		
Sapphire-corundum	...	...	...	...	...	...	(478)	...	...	...	W.
" " , synth.	...	...	...	...	...	...	**478**	...	...	...	W.
Spinel	...	(590)	555–**550–545**			(510)	...	**465–460–455**			W.
Iolite	...	...	...	...	**500–495–490**			...	...	...	W.
Blue glass	**655**	**590**	(550–540–530)			...	...	...	...	...	W.
Elements	Co	Co		Co		Ti	Ti		Co		

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[21] The index of refraction of manganosite. *Am. J. Sci.*, 38, 502–503, 1914.

The spectra of the four blue materials tabulated first are so dissimilar as to make this a suitable method for their identification. Synthetic sapphire shows a stronger band in the blue than the natural, making possible their distinction even when cut and mounted.

Spectrum-zone	ora.	yellow	gre.	blue	
Azurite	...	... ...	**510–495–480**		W.
Chalcanthite	(590–570–550)		... ...	...	W.
Linarite	(600–580–560)		... ...	...	W.
Element		Cu		Cu	

Rather unexpectedly, the stronger bands in these copper minerals are different in position. All show in addition general absorption in the yellow.

GROUP 5. COLOR VIOLET OR PURPLE.

Spectrum-zone	yellow	green	
Kunzite-spodumene	... ...	**560–540–520**	W.
" "	... ...	... **542** ...	W. & H.
Hexagonite-tremolite	(580–575–570)	... ...	W.
Hodgkinsonite	(590–580–570)	... ...	W.
Lepidolite	(580–575–570)	... ...	W.
Purple-glass	(590)	... (545) ...	W.
" "	... ...	 490	H.
Element	Mn	Mn	

Manganic manganese produces absorption bands in the yellow and green, but they are usually not very intense. Holden[22] found absorption in manganese glasses, however, to be at a maximum in the blue.

Spectrum-zone		red	ora.	yellow	green	blue	
Amethyst-corundum	–700	690–683–675	(590–575–560)		. . . . .	(475)	W.
Spinel	... ...	... ...	(590) ...	**555–** **550**	**–545**	(460)	W.
Kaemmererite	... ...	... ...	(610–585–560)		... ...		W.
Amethyst-quartz	... ...	... ...	... ...	... ...	(520–505–490)		W.
" "	... ...	... ...	... ...	... (550– 535 –520)	...		H.
" "	... ...	... ...	... ...	... 553±2 ...	... ...	...	W. & H.
Elements	Cr	Cr	Cr	Fe	Co,Fe	Fe Ti	

Both natural and synthetic amethyst-corundum, owing their color to two elements, show superimposed the spectra of ruby and sapphire. Amethyst-quartz was studied by Holden[23] and by Weigel and Habisch (*op. cit.*) yielding the bands tabulated on the last two rows.

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[22] The cause of color in rose quartz. *Amer. Mineral.*, 9, 102, 1924.

In conclusion, it may be pointed out that an apparatus which is capable of distinguishing so many similarly colored materials from one another, without requiring any physical or chemical treatment of the specimen, should certainly be a part of the equipment of every mineralogist's laboratory. To emphasize a few cases, the microspectroscope will distinguish almandite from pyrope, emerald-beryl from emerald-corundum, and gem-andalusite from alexandrite-chrysoberyl; it will tell ruby from every other red mineral, and decide whether it is natural or synthetic; and it will prevent glasses being mistaken for gem-stones of like colors, so that everyone who has gems brought to him for identification can use it. Students of sediment-petrography may find it helpful in identifying certain constituents of sands, especially monazite.

The microspectroscope is also serviceable in solving chemical problems, such as the presence of certain elements—chromium, vanadium, iron, titanium, manganese, etc.,—in colored materials; and there is room for additional research along this line. Besides the need of correlation of bands with composition in a number of cases mentioned above, the application of more intense light than heretofore employed will no doubt show many substances besides those here enumerated to possess characteristic absorption spectra. It is hoped, then, that the present article will encourage further investigation with this instrument.[24]

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[23] The cause of color in smoky quartz and amethyst. *Amer. Mineral.*, **10**, 233, 1925.

[24] An attempt has been made to present a fairly complete summary of the relevant literature; the writer will appreciate the receipt of information as to any omissions which may be discovered.

In response to many requests, it may be stated that the observations recorded in this paper as due to the writer (marked W.) were made with an Abbe-Zeiss "Spectroscopic eyepiece," although other makes of microspectroscopes will no doubt also give good results.

A BROAD SOURCE OF MONOCHROMATIC LIGHT

M. J. Buerger and H. A. Huntsinger,
Massachusetts Institute of Technology.

An efficient source of monochromatic light is essential to any precise determination of the optical constants of crystals and is even a necessity in many routine identifications of crystals having strong dispersions of principal optical elements,[1] or of crystals, which must be immersed in highly dispersive liquids. The simpler types of monochromatic illuminators usually suffer from one or more of several disadvantages; the light is not sufficiently intense, except when mechanically agitated, as by tapping; the heat given off is excessive, due to a large volume of flame; or the source of light is too narrow. In order to be of any use in obtaining the interference figures so essential to accurate work, the source must be sufficiently broad to fill the upper focal plane of the objective with light. Of course, a narrow source may be made to serve, with the aid of a lens, but the adjustment of such an optical system constitutes a continual source of annoyance.

In the design illustrated in Figure 1, these undesirable features are eliminated. A Bunsen burner or Tirrell burner forms the nucleus of the apparatus. In order to bring the source of the light nearer the level of the substage mirror, it is advisable to saw off and discard the upper half of the burner barrel. The end of the shortened barrel is equipped with a wing top flame spreader, *a*, of the type ordinarily used in bending glass tubing; this imparts breadth without excessive volume, to the flame. The active salt giving rise to the monochromatic light is fed into the flame from a platinum gauze trough,[2] *b*, which is welded to a piece of halfmillimeter platinum wire, *c*, which, in turn, is fused into a suitably bent pyrex glass tube, *d*. While the gauze may be independently supported by clamping the glass tube to a ring-stand, it is desirable to attach it directly to the burner barrel by means of a brass arm, *e*. The welding of the wire to the trough is easily accomplished after heating the platinum to a white heat in the flame of a burner; the two pieces are merely tapped smartly together with a hammer.

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[1] This difficulty is especially prevalent with certain colored inorganic salts as well as with many organic compounds.

[2] There are various ways of feeding the active ion into the flame, but this method, the writers believe, combines simplest construction and easiest manipulation with reasonably long life. The life of the flame, using lithium sulfate, is about five hours, varying somewhat with the salt capacity of the trough. A simpler feeder consists of a series of loops in platinum wire, each loop carrying a salt bead. The life of such an arrangement, however, is only about a quarter of an hour with lithium sulfate, or about an hour with sodium tetraborate. Another alternative may be had by treating a strip of perforated platinum foil as described by Peck (*American Mineralogist*, 7, 1922, pp. 104–106). The writers were unable to realize as long a life as that noted by Peck for this feeder, only two hours as a maximum being obtained for lithium sulfate. (N. B. Lithium chloride is so deliquescent that, when not undergoing ignition, it dissolves in its own absorbed water and drips away; lithium nitrate

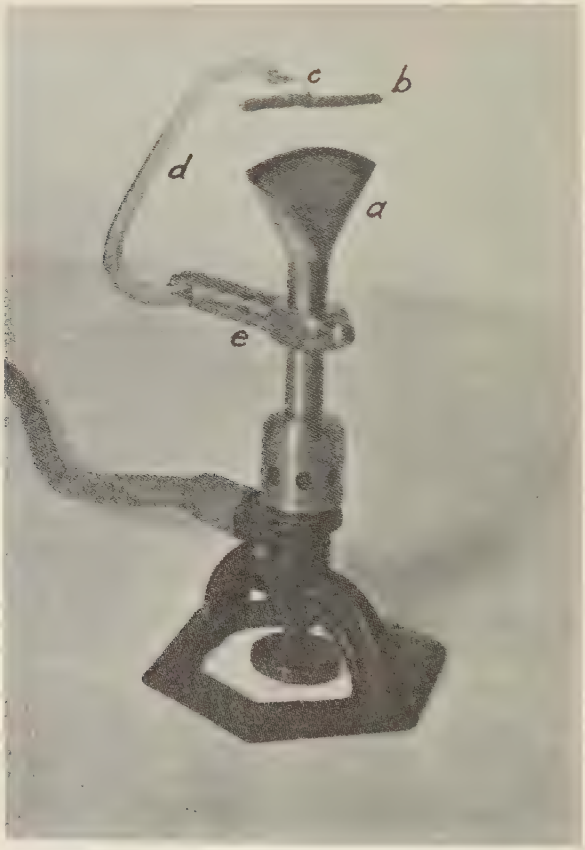

Figure 1.

In operation, the salt melts in the trough and the gauze dis-

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has a tendency to attack platinum, see Edward Thorpe: *Dictionary of Applied Chemistry, London*, 1913, **IV**, p. 304). Platinum black, electrolytically deposited on platinum foil, also does not give a very long life.

tributes it to the flame after the fashion of a wick. The trough should just touch the plane of the flame evenly at about the height of the top of the flattened blue cone. In starting the burner, however, the trough must be heated to whiteness within the flame and the salt melted before the operation is satisfactory.

It may be worth while to say a word as to the range of use of the monochromatic light source. It appears to be a prevailing opinion that work with monochromatic light must be done in a dark room. Such a small, enclosed space has the disadvantage of becoming easily heated. This circumstance renders working conditions uncomfortable and also necessitates the application of extreme and unreliable temperature corrections to the refractive indices of the immersion standards. By taking very simple precautions in local light shielding, the monochromatic source may be efficiently operated in a large, well-ventilated and normally illuminated laboratory, provided direct sunlight does not enter. The following arrangement of apparatus is recommended for microscopic work: The laboratory table should be near the center of the room, or at least well removed from the walls, in order that heat reflection from them be reduced to a minimum. If the observer works with his back toward the windows, his own shadow will exclude reflections by the sides of the crystal grains from this source. A black cloth screen suspended from a horizontal wire just in front of the microscope and reaching down to the level of the microscope stage, will similarly exclude direct reflections of the monochromatic light by the sides of the grains, as well as insulate the slide from this direct source of heat. A second black cloth screen should be placed a short distance beyond the light source for the purpose of excluding all light coming from this general direction except that of the desired monochromatic source. The use of cloth screens, in this manner, allows the normal air currents of the laboratory to freely circulate and carry off the heated air in the immediate region of the burner.

The standardization of refractive index liquids on a single-circle goniometer, using the minimum deviation, hollow prism method, may be carried on under equally comfortable conditions. A cloth screen is necessary behind the monochromatic source. A cardboard screen may be hung upon the collimator to insulate the prism from the direct heat of the burner, and another cloth screen can often be advantageously placed to exclude reflection of bright objects by the prism sides.

TWO-CIRCLE AND THREE-CIRCLE CO-ORDINATE ANGLES

Martin A. Peacock, *Harvard University*.[1]

In the course of a study of calaverite it was found necessary to compare G. F. Herbert Smith's[2] three-circle measurements with other series of measurements made on two-circle instruments. The co-ordinate angles obtained on the two types of goniometers are not directly comparable; but the relations, when found, are simple and either set of angles can be rapidly converted into the other by short logarithmic operations. The necessity of making such conversions may not occur again, but since the relations of the two types of measurements have not been emphasized before the present note may have theoretical interest.

The principle and method of use of Smith's three-circle goniometer are explained in papers in English and German,[3] and the Goldschmidt two-circle goniometer is widely familiar. The following two figures will therefore suffice to show the relations of the two sets of angles in the case, which will be the usual one, where the same zone of reference has been chosen in both modes of measurement. Figure 1 is a stereographic projection on a plane normal to the axis of the zone of reference. Y is the chosen origin-face of the three-circle measurements, and a face-pole P is defined by the angles B and A,[4] respectively, the azimuth and polar distance from Y as pole and the great circle in the plane of the projection as prime meridian. The same face-pole P is defined by the two-circle angles V and ρ, respectively, the azimuth and polar distance from Z as pole and the great circle through Y as prime meridian.

Figure 2 shows the relations in three dimensions. The crystal centre is at C, and CY, CX lie mutually at right angles in the plane normal to the axis of the zone of reference; CY is normal to the origin-face of the three-circle measurements. ZX′, ZY′, respective-

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[1] Commonwealth Fund Fellow, from the University of Glasgow.

[2] *Min. Mag.*, **XIII**, pp. 128–133, 1902.

[3] *Min. Mag.*, **XII**, pp. 175–182, 1899; *Zeits. Krist.*, **XXXII**, pp. 209–216, 1900; *Min. Mag.*, **XIII**, pp. 75–76, 1901.

[4] These are named ϕ and ρ in Smith's discussions; but to avoid confusion with the generally accepted significance of ϕ and ρ in two-circle goniometry the letters used by Smith to denote the circles on his instrument are here used for the angles read on those circles.

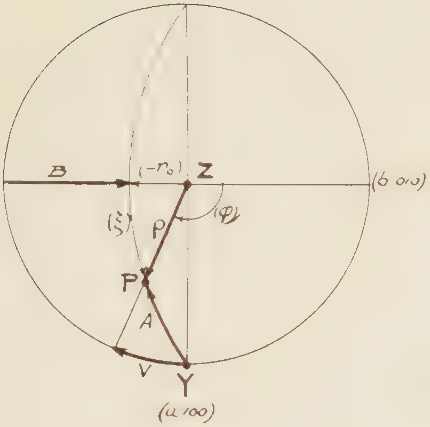

Figure 1

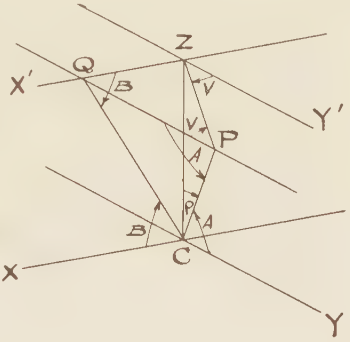

Figure 2

ly, parallel to CX, CY, lie in the gnomonic plane tangent at Z to the sphere with centre C and radius unity. P is the gnomonic face-pole defined by the angles B, A, and by V, ρ. QP, parallel to ZY′, is the projection of the zone containing the face-pole P and the origin-face Y. QZ, QP are the linear co-ordinates of P on the gnomonic plane; by expressing these co-ordinates separately in terms of B, A and V, ρ, and equating the values, B and A can be expressed in terms of V and ρ.

The following triangles are right-angled as indicated:

CZQ	right-angled at	*Z*
CQP	"	*Q*
CZP	"	*Z*
ZQP	"	*Q*

From these triangles:

$$QZ = \cot B \qquad (1)^{5}$$

$$QP = \cot A \cdot QC$$

$$= \cot A . \operatorname{cosec} B \qquad (2)^{5}$$

Again:

$$QZ = \sin V . \tan \rho \qquad (3)$$

$$QP = \cos V . \tan \rho \qquad (4)$$

Hence:

$$\tan V = \tan A . \cos B \qquad (5)$$

$$\cot \rho = \tan B . \sin V \qquad (6)$$

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[5] These are essentially the equations given by Smith for plotting three-circle measurements on the gnomonic plane (*Min. Mag.*, **XIII**, p. 312 and fig. 1, 1903).

Thus B and A can be converted in V and ρ, and similar equations for the reverse process can be readily derived.

In the general case B and A each range through two-right-angles while V will range from zero to 360° and ρ from zero to 90°. If the origin-face of the three-circle measurements is the side-pinacoid then V, as obtained above, gives a direct measure of ϕ when V is between 0° and 180°, and $(360° - V) = -\phi$ when V is between 180° and 360°. When a face in the prismatic zone other than the side-pinacoid is the origin-face of the three-circle measurements, V, as derived from B and A, is subject to a systematic addition or subtraction of the angle between the origin-face and the side-pinacoid to give ϕ. In the case of a monoclinic mineral with an orthodome zone of prismatic development, or a triclinic mineral, terminations of opposite ends may have been measured by the observers using the two different instruments: this was the case in the calaverite measurements. By changing the sign of V, as derived from B and A, and correcting for zero, the two sets of measurements were made comparable.

By means of the third circle C a new pole in the zone of reference can be brought to the position of origin-face in the course of three-circle measurements. Such a movement represents a shift of the two-circle prime meridian, affecting V directly by the amount of movement of C.

In the special case where the origin-face of the three-circle measurements is the front pinacoid, in any system except the triclinic, B and A are directly related to Goldschmidt's auxiliary angles η_0 and ξ, as shown in brackets in figure 1.

When B is acute: $(90 - B) = -\eta_0$
" B " obtuse: $(B - 90°) = \eta_0$
" A " acute: $(90° - A) = \xi$
" A " obtuse: $(A - 90°) = -\xi$
And $(90° + V) = \phi$

This case is realized in Smith's[6] measurements of krennerite, from which the following angles are taken. The angles η_0 and ξ are taken from Goldschmidt's *Winkeltabellen*. Krennerite is orthorhombic, and therefore the signs of η_0 and ξ can be neglected.

[6] *Min. Mag.*, **XIII**, pp. 266–267, 1903.

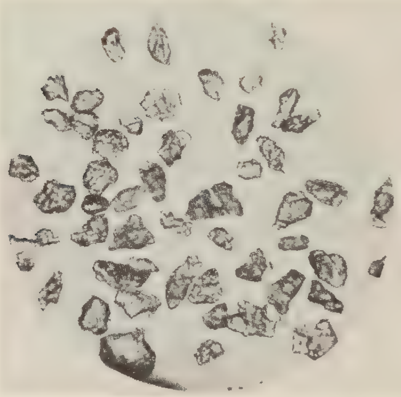
	Smith, 3-circle angles; *a*(100) as pole.				Goldschmidt, 2-circle angles; *c*(001) as pole.	
	B Azimuth	*A* Distance	$-\eta_0=$ $(90°-B)$	$\xi=$ $(90°-A)$	η_0	ξ
t 121	44° 35½′	69° 11½′	45° 24½′	20° 48½′	45° 24′	20°45′
o 111	63 07	64 17	26 52½	25 43	26 53	25 42

NOTES AND NEWS

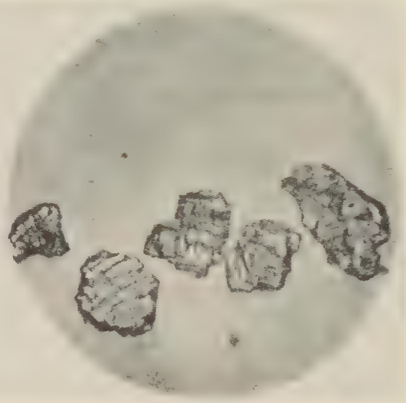
NATURAL ETCHING OF DETRITAL GARNET

M. N. Bramlette, *Yale University.*

Detrital grains of garnet in sandstones very commonly show a peculiar surface feature that has been observed by a number of workers in sedimentary petrography, but it has been only briefly mentioned in the literature as an unusual condition and generally misinterpreted. Actually the peculiarity is very common and therefore merits more consideration. In the Tertiary strata of Venezuela garnet of this type is especially abundant and beautifully developed, being quite characteristic of certain formations. Since becoming interested in this material from Venezuela, the writer has observed it commonly in sediments from various localities. Several British petrographers have mentioned garnet that is evidently of this same kind but have considered the peculiarity as a cleavage developed in the garnet. However, Mackie[1] noted its occurrence in the sandstones of Scotland and correctly attributed the result as due to etching.



Magnification 24x



Magnification 62x

The accompanying illustrations are of this garnet from the Tertiary of Venezuela. It is somewhat difficult to show the etched condition well in photographs, as the thickness of grains makes the focus sharp on only a small part of the grains. The appearance is very similar to a well developed cleavage, but a cleavage is not characteristic of garnet which breaks with a sub-conchoidal fracture. That it is not a cleavage is evident when the grains showing this feature are crushed, for they do not part along these surfaces but break with the usual conchoidal fracture. The effect is actually confined to the surfaces of the grains. Certain garnets do show a fairly well developed parting, but such garnet when tested by crushing was found to break with irregular to conchoidal surfaces, and gave nothing resembling the effect under discussion.

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[1] William Mackie: The Principles that regulate the Distribution of Particles of Heavy Minerals in Sedimentary Rocks, as illustrated by the Sandstones of the North-East of Scotland. *Trans. of the Edinburgh Geological Society*, Vol. **XI**, pp. 147–148, 1923.

Since it is obviously not a cleavage, there seem to be only two other possible explanations. Either it is a crystal growth of a secondary nature or it is a result of etching. It does not appear probable that it is a crystal growth, as there is no tendency to develop the typical crystal forms of garnet, nor have the rocks as a rule suffered any considerable metamorphism to initiate such recrystallization. The very sharp faces and angles as contrasted with the abraded shapes of associated mineral grains suggest that it is an authigenic effect, produced since transportation and deposition of the sediments.

Some ordinary garnet was crushed and treated with hydrofluoric acid. After several days of treatment in this acid, an etching of the surface of the grains was produced that is identical with that observed in the natural grains from sedimentary rocks. It seems, therefore, evident that this type of detrital garnet is a result of etching. Just what acid or alkaline solution in nature has produced the result is not known, but in many cases at least it is obvious that it is an authigenic change. Some of the grains are etched down by this natural process to delicate almost skeletal forms. It is thus probable, as pointed out by Mackie, that much garnet disappears from sedimentary rocks with sufficient time under certain conditions that are not uncommon.

NOMINATIONS FOR OFFICERS OF THE MINERALOGICAL SOCIETY FOR 1930

The Council has nominated the following officers of The Mineralogical Society of America for the year 1930.

President: Herbert E. Merwin, Geophysical Laboratory, Washington, D. C.

Vice-President: John E. Wolf, Pasadena, California.

Treasurer: Albert B. Peck, University of Michigan, Ann Arbor, Michigan.

Secretary: Frank R. Van Horn, Case School of Applied Science, Cleveland, Ohio.

Editor: Walter F. Hunt, University of Michigan, Ann Arbor, Michigan.

Councilor: 1930–1933, Paul F. Kerr, Columbia University, New York City.

The tenth annual meeting of the Society will be held December 26–28, 1929, at the Wardman Park Hotel, Washington, D. C. It is planned to publish in the December issue of the Journal a *preliminary* list of titles of papers to be presented before the Society at its annual meeting. In order to appear on the advance program titles of papers should be in the hands of the Secretary by *November 10.*

Frank R. Van Horn, *Secretary*

Mr. Lloyd W. Fisher has received the Ph.D. degree from Johns Hopkins University and has been appointed head of the Department of Geology at Bates College, Lewiston, Maine. The subject of his dissertation presented for his doctorate was "Chromite—its mineral and chemical composition."

An illustrated booklet of more than passing interest has recently been issued by the Eastman Kodak Co., Rochester, New York, entitled "X-rays in Industry."

The pamphlet describes in non-technical language some of the industrial applications of x-rays in examining the internal construction of opaque materials. The manner in which the x-rays are produced, the apparatus required, and rules for the proper exposure and manipulation of radiographic films are some of the points that are briefly discussed. A bibliography consisting of three books and twenty-four articles has been appended for those desiring further information. The Eastman Kodak Co. will mail this pamphlet to any interested party on request.

The first of a contemplated series of reports which will contain abstracts of current articles dealing with applied geophysics has been issued by the U. S. Bureau of Mines, Dept. of Commerce. The Bureau plans to secure the original papers from which these abstracts are prepared and to assist interested parties by furnishing translations or photostat copies. Circular No. 6120 contains abstracts of papers relating to gravitational, magnetic, seismic, electrical, geothermal and radioactive subjects.

PROCEEDINGS OF SOCIETIES

NEW YORK MINERALOGICAL CLUB

Minutes of the May Meeting

A regular monthly meeting of the New York Mineralogical Club was called to order by President Herbert P. Whitlock at the American Museum of Natural History on the evening of May 15, 1929.

Mr. Charles Pasewark of New York City was elected to membership.

A mineralogical trip on Memorial Day, May 30th, to the quarries at Bedford, N. Y., was decided upon.

The address of the evening, on "*The Geology of South Africa and the Diamond-Bearing Formations*," by Dr. George I. Finlay of New York University, was then presented. The general geology of South Africa was first described, and then the characteristics of the diamond-bearing kimberlite pipes. The mineralogical composition of the kimberlite and the various theories which have been advanced to account for the origin of the diamonds were discussed at some length.

Mr. Broadwell exhibited a specimen from Franklin Furnace, N. J., containing ten different minerals, two of which may prove to be new.

After a vote of thanks to Dr. Finlay the meeting adjourned.

George E. Ashly, *Secretary Pro-Tem.*

NEW MINERAL NAMES

LARNITE

C. E. Tilley: On larnite (calcium orthosilicate, a new mineral) and its associated minerals from the limestone contact-zone of Scawt Hill, Co. Antrim. *Mineralog. Mag.*, **22**, 77–86, 1929.

Name: From the name of the locality, Larne, in Co. Antrim, in the vicinity of which the mineral occurs.

Chemical Properties: Calcium orthosilicate, Ca_2SiO_4 or $2CaO \cdot SiO_2$. Larnite is attacked slowly by water with production of $Ca(OH)_2$, the solution turning red litmus blue. It is decomposed readily by dilute acid without effervescence, but with gelatinization. An analysis of larnite containing very small amounts of spurrite ($2Ca_2SiO_4 \cdot CaCO_3$) gave: SiO_2 31.00, Al_2O_3 1. 12,Fe_2O_3 trace, FeO 0.64, MgO 0.69, CaO 64.98, CO_2 0.82, H_2O at 105°C. 0.61; total 99.86. The CO_2 is present as spurrite and the Al_2O_3, FeO and MgO as finely divided spinel.

Physical and Optical Properties: Color gray. Grains show one good cleavage and an imperfect cleavage 90° thereto. Most characteristic feature is exceedingly fine polysynthetic twinning parallel to the prominent cleavage. Less commonly a second set of twin-lamellae is developed at right angles to the first set. Optically +, with a moderately large optic axial angle; $\alpha=1.707$, $\beta=1.715$, $\gamma=1.730$. Sections cut perpendicular to the acute bisectrix (γ) show a symmetrical extinction of the adjacent lamellae of the very fine polysynthetic twins, the orientation being α:twin-line = 13–14°. In sections cut perpendicular to the obtuse bisectrix the mineral has straight extinction with reference to the cleavage, and no twin structure is visible. These properties are those of a monoclinic mineral where $\gamma=b$. Larnite falls to a powder on heating and cooling or if it is subjected to shock. The $\gamma-Ca_2SiO_4$ or low temperature form of calcium orthosilicate is produced by this "dusting" and has much lower indices of refraction. A similar phenomenon takes place with Ca_2SiO_4 prepared synthetically at high temperatures and is the cause of the "dusting" of cement.

Occurrence: Larnite is found in the contact zone of chalk and Tertiary dolerite at Scawt Hill, near Larne, Co. Antrim. It occurs with calcite, spurrite, melilite (gehlenite), merwinite, spinel, perovskite and wollastonite.

The chief assemblages of the contact-zone are:

(a) spurrite
(b) spurrite-larnite
(c) spurrite-larnite-melilite
(d) spurrite-melilite-merwinite-spinel-larnite

all with calcite.

Discussion: May be accepted as a mineral species. Tilley in a footnote says: "The Tasmanian mineral recorded as calcium orthosilicate by F. P. Paul (*Tsch. Min. Petr. Mitt.*, **25**, 309, 1906) and named shannonite (C. E. Tilley, *Geol. Mag.*, **64**, 144, 1927) on the basis of Paul's data, has since been shown to be monticellite (C. E. Tilley, *Geol. Mag.*, **65**, 29, 1928). Rather than transfer the name 'shannonite' to the new mineral now described, any further confusion will be avoided by adopting a new name."

J. F. Schairer

COOPERITE

R. A. Cooper: A new platinum mineral in the Rustenburg norites. *J. Chem. Met. Mining Soc., S. Africa*, **28**, 281–3, 1928.

F. Wartenweiler: Discussion appended to the above paper page 283. In this discussion Wartenweiler suggests the tentative name of cooperite for the mineral.

Name: Tentative suggestion of the name cooperite after R. A. Cooper who described the mineral.

Chemical Properties: Material obtained from gravity concentration of 1 1/2 tons of ore from Rustenburg district, Transvaal, indicates a sulpharsenide of platinum of the composition Pt 64.2, Pd 9.4, S 17.7, As 7.7; total 99%. The Pt, S and As together conform to the formula Pt $(S, As)_2$. Cooper believes that "the majority of the palladium exists independently of the platinum" and its presence is due to the difficulty of making a clean separation. The material is so nearly insoluble in aqua regia after many hours of treatment that only traces of Pt were found in solution. A specimen of a platinum sulfarsenide from the Onverwacht dunite deposit gave Pt 59.3, S 3.7, As 36.9; total 99.9%. Cooper says: "this materia. approximates much more closely to normal sperrylite, but is nevertheless distinct."

Physical Properties: Color a grayish steely color. Irregular fragments or very complex crystal forms with occasional elongated rectangular rods.

Occurrence: Found as disseminated grains in the platiniferous norites of the Rustenburg district of the Transvaal. Needs much further study.

J. F. Schairer

TANTEUXENITE

E. S. Simpson: Contributions to the mineralogy of Western Australia, Series 3 *J. Roy. Soc. Western Australia*, 14, 45–56, 1928.

Name: From its chemical compn. A euxenite with tantalum replacing columbium (niobuim).

Chemical Properties: It is essentially a titanotantalate of yttrium, Yt_2TaO_8, with probably $CaTiTa_2O_8$ and $Yt_2Ta_2O_8$. Three analyses given.

Physical Properties: Color brownish black. Subconchoidal fracture and resinous lustre. H. = 5–6. Thin splinters are amber-yellow and optically isotropic. Indistinct crystals are tabular and orthorhombic. Specific gravity is higher than euxenite. Gr. = 5.4–5.9.

Occurrence: Derived from pegmatite at the Pilbara goldfield, N. W. Div. Found at Cooglegong and Woodstock.

J. F. Schairer